GEOTHERMAL FLUID LEAKAGE IN THE LOWER EAST RIFT ZONE OF KILAUEA VOLCANO, HAWAII, HAWAII

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ABSTRACT

An integrated analysis of the geology, hydrology and groundwater chemistry of the southeastern portion of the island of Hawaii has been conducted. Thirteen well data sets pertaining only to the very top of the shallow groundwater system, were reveiwed. While a paucity of well data exists relative to the area studied, the integrated approach has allowed for an initial interpretation of the regional geohydrochemical systemmatics. The study identified the presence of three basic shallow groundwater types: geothermal, fresh and mixed. Seawater intrusion, which undoubtedly occurs along the coast of the island, was not considered. The presence of geothermal water in the shallow groundwater system is a direct indication of leakage from a geothermal reservoir.

Geothermal groundwater is conservatively defined as having two of the following three characteristics: a total dissolved solids content equal to or greater than 2000 mg/L, a temperature equal to or exceeding 100°F and/or a chloride to magnesium ratio in excess of 15. It is found in an area proximal to a structural intersection of the east-northeast trending lower East Rift Zone of Kilauea Volcano with a north-northwest trending transverse fault, an in the region south and southeast of this structural break. Fresh groundwater is defined on the basis of location and having two of the following three characteristics: a total dissolved solids content, temperature, and a chloride to magnesium ratio less than 500 mg/L, 84°F and 15, respectively. It exists north of the lower East Rift Zone and south of the rift in the region southwest of the structural intersection. Mixed groundwater, also defined on the basis of location, has chemical and temperature characteristics intermediate to the other two types. It is located within the rift zone east-northeast of the structural break.

The structural intersection which occurs in the Puulena Crater-Puu Honuaula area, is interpreted to be a conduit for upwater migration of geothermal fluids from a deep, high temperature/pressure reservoir into the overlying shallow and intermediate depth groundwater system. As the upwelling geothermal fluid reaches shallow depths, it moves laterally, following topography towards the sea. Two plumes of geothermal groundwater are evident. One flows within and parallel to the rift, progressively interacting with increasing amounts of meteoric water recharge (rainfall) to form the mixed water zone near Kapoho Crater. The other, being unconfined by the rift structure, forms a relatively broad plume flowing south-southeast of the rift and discharging along a portion of the island's southeastern coast as warm springs and seeps. A self-potential anomaly defined by Zablocki (1977) corroborates the postulated geothermal fluid leakage along the structural intersection. The southern geothermal plume is coincident with a low resistivity anomaly reported by Flanigan and Long (1987).

The upflow of geothermal fluids from the reservoir, while not directly measured, must be sufficient to alter a large meteoric (fresh) water input. For example, the annual meteoric water recharge rate over that portion of the geothermal groundwater area within the rift and discharging along the coast, is about 110 inches. No surface water bodies are present as a result of the high permeability of the young, subaerial lavas. Infiltration of fresh water into the top of this groundwater system is estimated at 70 million gallons per day. Since fresh water is not detected in the area, the geothermal fluid leakage rate is inferred to be significant.